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LANDSAT Follow-on Investigation #22510
Type II Progress Report #2 - 1 September 1975

The Use of LANDSAT DCS and Imagery in Reservoir Management and Operation

Principal Investigator
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Waltham, Mass. 02154

ORIGINAL CONTAINS COLOR ILLUSTRATIONS

The New England Division, Corps of Engineers (NED) continues to assess the separate and coordinated uses of the LANDSAT data collection and imaging systems for flood control reservoir management and operation.

The imagery portion of the investigation is being accomplished primarily by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire. The Co-Principal Investigator of our ERTS-1 project, Dr. Paul Bock of West Hartford, Connecticut is being retained in the follow-on investigation as a consultant.

Location listings of our operating DCP's as of 13 August follows. Please note changes from the list submitted with our last quarterly progress report. Also inclosed is a copy of our revised Data Collection System site map for New England.

We have installed a data collection platform on the Saint John River in Maine at the Dickey bridge, approximately one mile upstream of the confluence with the Allagash River. A Martek water quality monitor was installed and interfaced to the DCP and is currently transmitting the following information: temperature, conductivity, pH, dissolved oxygen and also river stage. A computer program to convert the output to real numbers has been developed and is being used. The data obtained will serve as a baseline for the Saint John River at varying flows and seasons as part of the water sampling program for the proposed Dickey-

(E76-10068) THE USE OF LANDSAT DCS AND IMAGERY IN RESERVOIR MANAGEMENT AND OPERATION Progress Report (Corps of Engineers, Waltham, Mass.) 7 p HC $3.50 CSCL 05A
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LANDSAT-2 - DCP INFORMATION SHEET
ARMY CORPS OF ENGINEERS, NEW ENGLAND DIVISION 13 AUG, 1975

DCP NO.	STATION NAME	PARAMETER(S)*	LAT	LONG
7273	ST. JOHN RIVER AT NIMEMILE BRIDGE, ME.	RS	46 42 00	69 42 59
7101	ST. JOHN RIVER AT DICKEY, ME.	RS WQ	47 06 44	69 05 25
7220	ST. JOHN RIVER AT FORT KENT, ME.	RS	47 15 27	68 35 35
7071	PENOBSCOT RIVER AT WEST ENFIELD, ME.	RS	45 14 12	68 38 56
7272	CARABASSETT RIVER NEAR NORTH ANSON, ME.	RS	44 52 09	69 57 20
7356	SACO RIVER AT CORNISH, ME.	RS	43 48 35	70 46 53
7170	STINSON MOUNTAIN, N.H.	P	43 50 06	71 46 49
7127	SOUTH MOUNTAIN, N.H.	P	42 58 59	71 35 21
7201	PEMIGEWASSET RIVER AT PLYMOUTH, N.H.	RS	43 45 33	71 41 10
7233	MERRIMACK RIVER NEAR GOFFS FALLS, N.H.	RS	42 56 54	71 27 52
7246	WACHUSETT MOUNTAIN, MA.	P	42 29 24	71 53 15
6063	IPSWICH RIVER NEAR IPSWICH, MA. (1)	RS	42 39 35	70 53 39
7106	NORTH NASHUA RIVER AT FITCHBURG, MA.	RS	42 34 34	71 47 19
7242	TOWN RIVER AT QUINCY, MA.	RS	42 14 52	70 59 52
7142	CHICOPEE RIVER AT CHICOPEE FALLS, MA.	WQ	42 09 37	72 34 52
7021	WESTFIELD RIVER AT WEST SPRINGFIELD, MA.	WQ	42 05 59	72 38 28
7207	FRENCH RIVER AT WEBSTER, MA.	WQ	42 03 03	71 53 08
	NED HEADQUARTERS, WALTHAM, MA. (5)	T	42 23 46	71 12 56
7304	BRANCH RIVER AT FORESTDALE, R.I.	RS	41 59 47	71 33 47
7345	PAWTUXET RIVER AT CRANSTON, R.I.	RS	41 45 03	71 26 44
7254	CONNECTICUT RIVER AT HARTFORD, CT.	RS	41 46 10	72 40 04
7335	CONNECTICUT RIVER NEAR MIDDLETOWN, CT.(4)	RS	41 33 40	72 36 45
7206	PORTER BROOK NEAR MANCHESTER, CT.(2,4)	P&/OR RS	41 45 55	72 30 12
6325	UNALAKLEET WATER SUPPLY RES., ALASKA (3)	RL AT GST GT WP	63 54 30	160 45 10
6216	SUSITNA RIVER AT DEVIL CANYON DAMSITE, ALASKA (3)	WES AT GST WP	62 48 58	149 18 43
7042		(3,4)		
7147		(3,4)		

SPARE DCP' S....7010, 7012, 7171, 7271, 7355

* P - PRECIPITATION
WES - WATER EQUIVALENT OF SNOWPACK
RS - RIVER STAGE
RL - RESERVOIR LEVEL
WQ - WATER QUALITY (TEMPERATURE, CONDUCTIVITY, PH AND DISSOLVED OXYGEN)
AT - AIR TEMPERATURE(S)
GST - GROUND SURFACE TEMPERATURE
GT - GROUND TEMPERATURE(S)
WP - WIND PASSAGE
PV - PARAMETERS VARIABLE
T - TEST SET

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(1) DCP BELONGS TO U.S. GEOLOGICAL SURVEY, BOSTON, MA.
(2) DCP ON LOAN TO U.S. GEOLOGICAL SURVEY, HARTFORD, CT.--ON DEMONSTRATION AT THE MANCHESTER NATURE CENTER
(3) DCP ON LOAN TO U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LAB, HANOVER, N.H.
(4) NOT YET INSTALLED
(5) NO DCP ASSIGNED TO THIS SITE AT THE PRESENT TIME

LANDSAT—2 DATA REPORTING STATIONS

LEGEND

LANDSAT STATIONS

- RIVER STAGE
- PRECIPITATION
- WATER QUALITY
- TEST SET

NED RESERVOIR

DICKEY
FT. KENT
CARIBOU
NINEMILE BR.
HOULTON
MAINE
KENNEBEC RIVER
W. ENFIELD
PENOBSCOT RIVER
BANGOR
N. ANSON
CANADA
ST. ALBANS
BERLIN
MONTPELIER
ANDROSCOGGIN RIVER
AUGUSTA
NEW HAMPSHIRE
VERMONT
PLYMOUTH
CORNISH
PORTLAND
STINSON MT.
CONNECTICUT RIVER
OCEAN
DOVER
CONCORD
PORTSMOUTH
SOUTH MT.
GOFFS FALLS
BENNINGTON
IPSWICH
ATLANTIC
FITCHBURG
WALTHAM, NED HDQRS.
WACHUSETT MT.
MASSACHUSETTS
BOSTON
QUINCY
WEST SPRINGFIELD
CHICOPEE FALLS
WORCESTER
PROVINCETOWN
WEBSTER
FORESTDALE
HARTFORD
MANCHESTER
PROVIDENCE
CRANSTON
CONNECTICUT
RHODE ISLAND
MIDDLETOWN
NEW YORK
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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
AUGUST 1975

Lincoln Reservoir complex. Also, during the fall, snow pillows will be interfaced to 2 DCP's in the Saint John River basin area to obtain real time information on the water equivalent of the snowpack.

Note the planned installation of a DCP at Porter Brook near Manchester, Connecticut in cooperation with the U.S. Geological Survey. This will be a continuing public demonstration at the Manchester Nature Center and should provide an excellent opportunity to acquaint the public with the role of satellites for data relay from in situ environmental sensors.

CRREL continues field experimentation with two DCP's in Alaska and plans to activate two more sometime in the near future. The DCP located at the Devil Canyon dam site on the Susitna River in Alaska has been in operation since October 1974. Data monitored at this site has been utilized as a data base for the South Central Railbelt Project, Alaska District, Corps of Engineers. The following information has been transmitted: water equivalent of the snowpack, air temperature, ground surface temperature and wind passage. During the week of 1 June 1975 a DCP was installed at Unalakleet, Alaska to transmit reservoir water level, air temperature, ground surface and ground temperatures and wind passage. These data will provide information to develop design criteria for dams located within permafrost. Ground surface and ground temperature measurements are taken by means of 64 thermistors located in four bore holes (maximum depth of 150 feet) located in the reservoir. A switching circuit enables the four sets of thermistors to be read in sequence each day. Ground temperature data has been limited to 2 depths due to malfunction of the switching circuit, however this is currently being repaired.

DCS data relay from NASA via our real time teletype link continues with a nominal lag of 45 minutes. Punched cards and computer printouts usually arrive by mail within a week of data acquisition by NASA. We are still recording and analyzing DCP, sensor and battery performance and reliability. An updated summary of our statistics will be presented in a future progress report.

The LANDSAT DCS hardware continues to perform well. Necessary DCP repairs are still being accomplished in a commendable

and timely manner by personnel at NASA, Wallops Station, Virginia. Turnaround time has usually ranged between 1 and 3 weeks.

NED's direct LANDSAT DCS ground receive facility or Local User Terminal (LUT) was completely installed as of 15 September and is now undergoing initial testing. The LUT has tracked LANDSAT a number of times, but not on a regularly scheduled basis. Valid data is being acquired, however, and we expect soon to be in a quasi-operational mode.

In the imagery investigation we are proceeding to analyze by computer techniques hydrologic parameters relevant to NED reservoir management and control functions. The ultimate goal of this is the development of an interactive computer processing system for depicting and manipulating hydrologic data from LANDSAT imagery on a real time basis.

During this quarter data from the LANDSAT computer compatible tape of the Franklin Falls Dam, New Hampshire for 6 July 1973 was analyzed to quantify the extent of flooding utilizing an algorithm developed by the Goddard Institute for Space Studies, New York City. This computer program converts the instrument counts from each of the four multispectral bands into true radiance values. The albedo value can be separated from the true radiance value in each band, resulting in a normalized color value which is not usually observed in algorithms used in the analysis of LANDSAT multispectral data.

Utilizing the above program a total of 1,616 acres was quantified as water concurrent with the ground truth pattern in the noncloud-covered portions of the Franklin Falls reservoir area. In the north end of the reservoir, which was partially cloud-covered, an additional 630 acres of water were estimated from the imagery indications. The total surface area of water impounded by the reservoir, as determined from ground truth, was 2,430 acres. Thus the imagery, under less than ideal cloud-cover conditions, delineated about 90 percent of the water surface area.

Further imagery work will be focused on additional quantification of the accuracy of delineating floodwaters using the Goddard Institute algorithm. We also intend to investigate the following hydrologic parameters directly related to reservoir regulation:

soil moisture, water content of the snowpack.

During the recent quarter we requested that the coordinates enclosing the area of coverage for our imagery standing order be changed, so as to reduce the amount of imagery received and thus increase the number of passes that could be handled by available funding. For the same reason we also requested that our cloud cover requirements be changed so that we would receive only images with cloud coverage of 30 percent or less. Both of these changes were implemented as of 1 July 1975.

Receipt of LANDSAT imagery from the EROS Data Center has usually ranged from 4 to 8 weeks after data acquisition by NASA. This continues to be acceptable for our current studies, but by no means approaches the 'real time' required for reservoir regulation purposes. Imagery quality has vastly improved since the start of our follow-on investigation and in many recent cases has exceeded the highest quality achieved by NASA during our ERTS-1 investigation. A tabulation of the dollar value of the imagery data ordered and received through 28 August 1975 for this investigation is as follows:

Type of Imagery	Value of Data Allowed	Value of Data Ordered	Value of Data Received
LANDSAT Prints and Transparencies (standing order)	A total of $5,900	Does not apply	$5,726
LANDSAT Prints and Transparencies (retrospective orders)		0	0
LANDSAT Computer Compatible Tapes	$5,800	0	0
Aircraft Imagery	$ 360	0	0

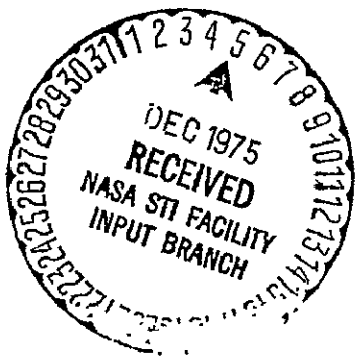
As in our original ERTS-1 investigation, we consider communication and exchange of information with others regarding LANDSAT as vital to the overall success of our participation in the program. Throughout the reporting period we have hosted numerous guests from the data collection and imagery communities interested in our progress, including representatives from NASA, the U.S. Geological Survey and the North Central Division, Corps of Engineers. Also we were interviewed by Mr. Arthur Corte of the Center for Policy Alternatives, Cambridge, Massachusetts concerning the scope of application of the techniques and programs resulting from LANDSAT.

During the reporting period, Dr. Paul Bock attended the Earth Resources Survey Symposium held on 8-13 June at Houston, Texas where he presented a paper, co-authored with Mr. Saul Cooper and Dr. Joseph Horowitz of NED and also Mr. Dennis Foran, and entitled: "The Use of ERTS DCS and Imagery in Reservoir Management and Operation." Preparations have started for papers to be presented at the Tenth International Symposium on Remote Sensing of Environment from 6-10 October at Ann Arbor, Michigan, the International Telemetering Conference from 14-16 October at Silver Spring, Maryland, and the Eleventh Annual Meeting of the American Water Resources Association from 9-14 November at Baton Rouge, Louisiana.

Total NASA funds expended on this investigation as of 31 August 1975 are $12,818.

Saul Cooper

SAUL COOPER
Principal Investigator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